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The role of seaports as logistics centers in the modelling of the sustainable system for distribution of goods in urban areas

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Abstract

This publication presents subject matter connected with the role of seaports as integrated logistics centers in the development of sustainable distribution of goods in urban areas.
Seaports as integrated logistics centers and multifunctional socio-economic spaces are the key components of the European and global transport system. They carry out the functions and services necessary for the efficiency of supply chains, and their final elements include the distribution of goods from the places of production to places of consumption. Seaports cover the transport, logistic, distribution and spatial functions, which influence city development, while logistics centers cover the distribution function.
The development of seaports is a result of their multifunctionality and multimodality focused on the widening of the range of services, which allows them to meet different demands of the environment. Thus, seaports and logistics centers have become elements of urban transport systems included in the EU policy of sustainable development of transport. Particularly important here is the latest implementation of the objectives of the EU White Paper on the development of resource-efficient and low-carbon transport in ecological urban transport.
The publication presents existing solutions and possible directions concerning the activity of seaports as logistics centers in the area of urban logistics.

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Keywords: supply chain; distribution; seaport; logistics centers; seaport functions; congestion; pollution.

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1. Introduction

For centuries European seaports have evolved by adapting their activities to the external environment. Political changes, the great geographical discoveries, wars, colonial expansion of European countries, economic development, social crisis, technical development or industrial revolution are only examples of external factors affecting the functioning of seaports. These factors have stimulated their development and affected the regulations for their functioning and organization. Seaports were and are created to become such organizations, and the scope of implementation of their various objectives and spatial functions have an impact on the form of legislation, as well as the place and role of seaports in the transport and economic state of the region or city.

For years seaports have been perceived as areas, '…situated at the interface between land and sea with economic facilities properly prepared with regard to technical-technological and organizational handling of foreign trade, carried out by sea, designed to serve maritime and land transport engaged in their carriage' (Szwankowski, 2000). However, this is the traditional perception of the role of ports in the transport and economic systems and their role in the development of countries, regions and cities should be seen differently.

Currently, seaports have become a key part of the supply chain network. Seaports are important economic spaces, which provide a wide range of services and serve a wide range of customers including shippers, forwarders, transport companies and logistics operators. One of their main task is to facilitate the domestic and international trade of goods, often on a large scale. ***Seaport is a socio-economic space with the multi-faceted impact on the environment combining the processes of transport - thanks to the technical and technological equipment - between the sea and the mainland, which are interpenetrating, interdependent and interrelated, and which provide objective and spatial functions related to the trade and movement of people***[†] (Montwiłł, 2011).

The continuous development of logistics chains and their network system is possible due to the developed node-link system, where the most important nodes are seaports and integrated logistics centers. Therefore, they have also become key elements of distributions systems in highly urbanized areas focused on the spatial range of services related to the transport, forwarding and logistics to optimize supply, which leads to the reduction in congestion and other external costs of transport.

2. Seaports as logistics centers

Nowadays, seaports can be divided into three generations in terms of their level of modernity and openness to innovation. This division is not the result of their size, location or management, but the features that characterize their activities (Table 1). In the global transport system there are functioning ports of different generations, and European ports of the first or second generation continue to be an important element in local delivery systems. But the most important role in the supply chain network is fulfilled by the port of the third generation. Therefore, ports are important for the functioning of the world economy, and the effective competition between ports and their services plays an important role in the final price of many products.

The third generation of seaports perform similar tasks and provide the range of activities similar to the ones of integrated logistics centers. After 1995 the development of the network delivery system has led, according to many analysts, to the transformation of the leading ports to the fourth generation of ports, which is associated with the adoption of the new tasks characteristic for centers or logistic platforms. Using available research material A. Grzelakowski (Grzelakowski & Matczak, 2012) indicates that the port of fourth generation is characterized by a set of factors, where:

- main cargo is containerized in large containers,
- port development strategy is based on the use of advanced automation and information technology;
- scope of activity means full integration in the Transport Forwarder & Logistics sector, intermodalizm and standardization of information;

[†] author's own definition

- character of an organization and management model is focused on the globalization of port activities and orientation towards SCM (Supply Chain Management) and control of environment;
- the port is characterized from the point of view of service processes and its variety of management tools, such as TQM (Total Quality Management), change management, HRM (Human Resources Management), process management and automation of service processes;
- fundamental factors are: innovation, technology, and information.

Table 1. Characteristics of seaports of the first, second and third generation (UNCTAD TD/B/C.4/AC.7/14, 1991)

	I generation	**II generation**	**III generation**
Limit dates	Until 1960;	After 1960	After 1980
Dominant factors	Labor and capital	Capital	Capital. Technology and know-how
Dominant tape of cargo	Dry bulk cargo, Other cargo nes,	Dry and liquid bulk cargo, Other cargo nes,	Dry and liquid bulk cargo, Large containers Ro-ro mobile
Main objective function	Transport	Transport, Industrial, Commercial	Transport, Logistics & distribution
The basic role of the port	Transport hub / note	Transport-industrial complex connected to commercial center	Distribution center / Logistics center / Logistics platform, Information center
Strategy	Conservative	Expansive	Market
Basic principle of the strategy	Seaport waiting for cargo	Port acquires areas, and stimulates the development of the port industry, thus obtains loads	Port co-creates supply chains
Range of service	Handling and storage services for the cargo. Simple administrative services, manipulation and control for cargo	Handling and storage services for the cargo. Processing and production of goods Complex administrative services, manipulation and control for cargo	Handling and storage services for the cargo. Distribution cargo Logistics services for cargo Gathering and processing of information Organization chain supply
VAL	Low	Higher	High
Operating principles the port environment (internal environment harbor)	Atomization Informal relationships with port users	There are no permanent links between deferent sectors port A close relationships with port users Ad hoc relationships with city	Unity of action sphere of operation Integration of organizational or capital sea port companies with its users Close relationship with the port city and region

This can be supplemented by ascertainment that the transformation of seaports from the third generation to the fourth generation applies to the enrichment of objective functions of these ports (Semenov J. 2003): wholesale trade, passenger traffic and tourism. These are areas, which connect water and land passenger streams, industrial multimodal and intermodal transport as well as port and urban functions, simultaneously realizing the port's function and connecting it, for example, with the trade, distribution, logistics and urban aspects, such as: services, industrial and communications functions.

The fourth generation of European seaports and integrated logistics centers have become centers of information for supply chain networks and places for locating distribution centers. This allows for the optimization of distribution and transport processes in the sequential organization of deliveries to individual customers located in urban area. Such actions result in reduced congestion in urban area by reducing transport and coordinating deadlines and order deliveries to individual customers of the urban transport system.

3. Seaport functions as logistics centers and their range of services

The socio-economic space of the third and fourth generation of seaports are realized in their objective and spatial functions. Their development is a consequence of the interaction between external and internal environment of the seaport. Figure 1 presents port functions realized in the ports of the third and fourth generation which are the key elements of the supply chain of the network system.

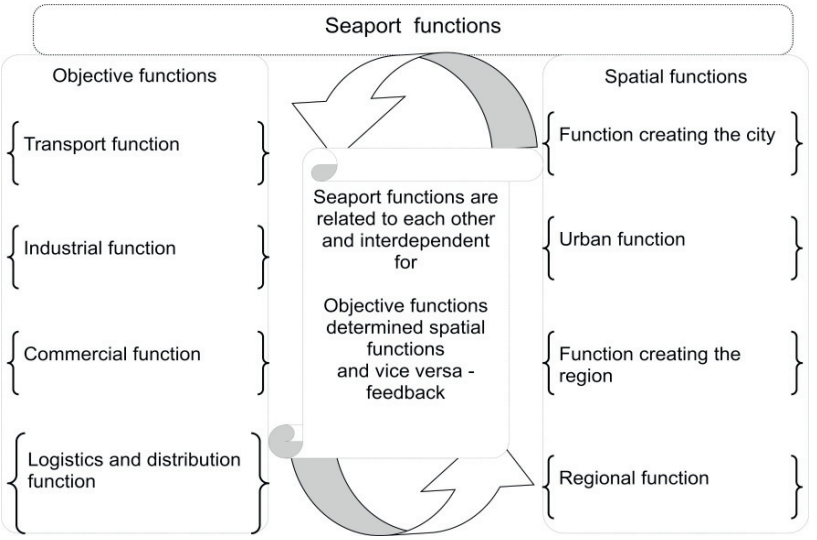

Figure 1 Seaport functions (Montwiłł, 2011)

'…the development of the contemporary major seaport-city interface is different than it was some 20 years ago, and that this has implications for the way it is to be approached and handled by the actors involved. A major seaports' evolution has become subject to a much more elusive set of factors, and its development process is currently being evaluated and re-conceptualized in practice as well as in theory.' (Daamen, 2007)

A change in the relationship between a seaport and a city indicated by Daamen is the result of changes in the management of ports in the 80s of the twentieth century and the new philosophy of their activities. The largest and most important seaports started becoming ports of third generation, where one of the characteristics of their operation is a closer relationship with the port city and region. Consequently, this leads to the rebuilt of seaports and city links. History has made a full circle. Seaports and cities returned to the symbiosis, as in the medieval times of port-towns or port-cities of Italy and the Hanseatic League.

The most spectacular example in Europe is the seaport of London, where the areas outside the city center along the famous docks of London have become a powerful district in which the city executes its commercial, residential and cultural functions, while the port has its commercial, logistics and distribution activities. Areas attractive from the land are also attractive from the water, becoming a center of tourism and passenger journeys by land and sea. The same part of the port creates a uniform spatial and functional area, blurring the border between these two organisms.

The author introduced a new urban function to a group of spatial functions, which allows situations to be distinguished where a port city enforces territorial expansion (function creating the city) from a situation where existing seaport areas and urban areas are revitalized and intensively used for the development of different functions created by the seaport and the port city.

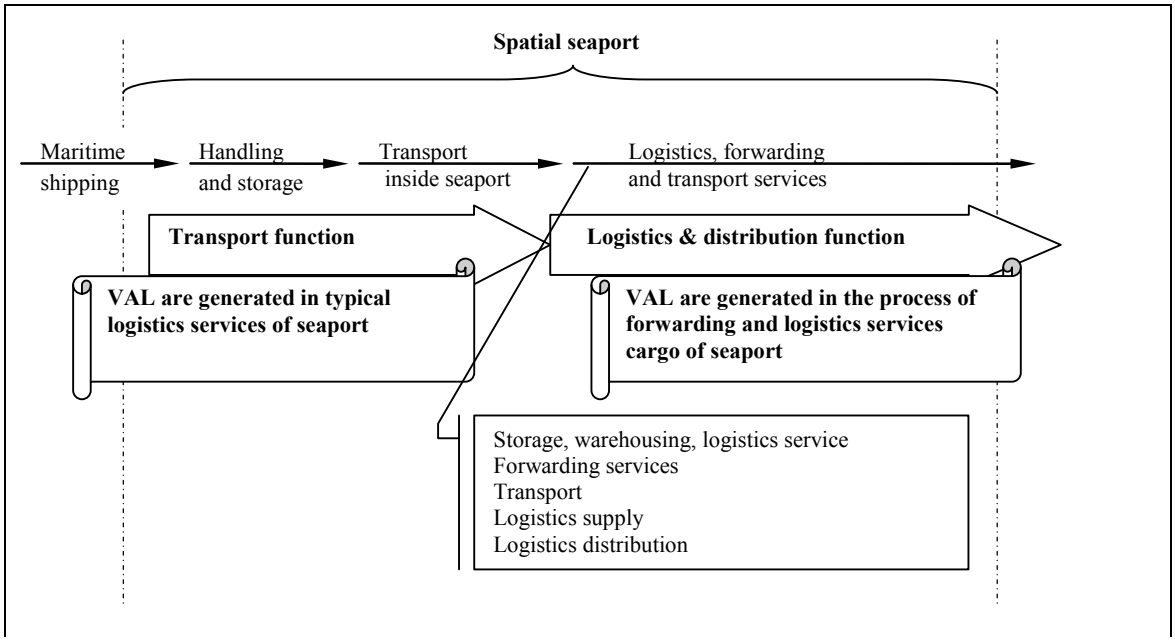

Fig 2. Diagram of cargo handling in the ports of the third and fourth generation, along with the areas of VAL generation (Montwiłł 2013)

The diagram of cargo handling in the seaport of developed logistics and distribution function presented in Figure 2 shows two main areas that make up the logistics system of the seaport. Typical services in the area of transport function include (UNCTAD, 2004):

- cargo handling and transfer operation,
- storage and warehousing,
- break / bulk and consolidation,
- cargo storage and manipulations, and
- customs and phytosanitary clearance.

These elements could constitute a good benchmark for ports claiming to operate as *maritime logistics centers* (UNCTAD, 2004).

Ports may also be seen as inland logistics centers, when they act as nodal interfaces intersecting the different segments of the inland transport system, such as road/rail, road/road, rail/rail, and even rail/road and air combinations.' (UNCTAD, 2004). Figure 3 presents a diagram of the seaport functioning as a logistics center, where it is possible to define the functional space of maritime logistics centers as well as the functional space of inland logistics centers.

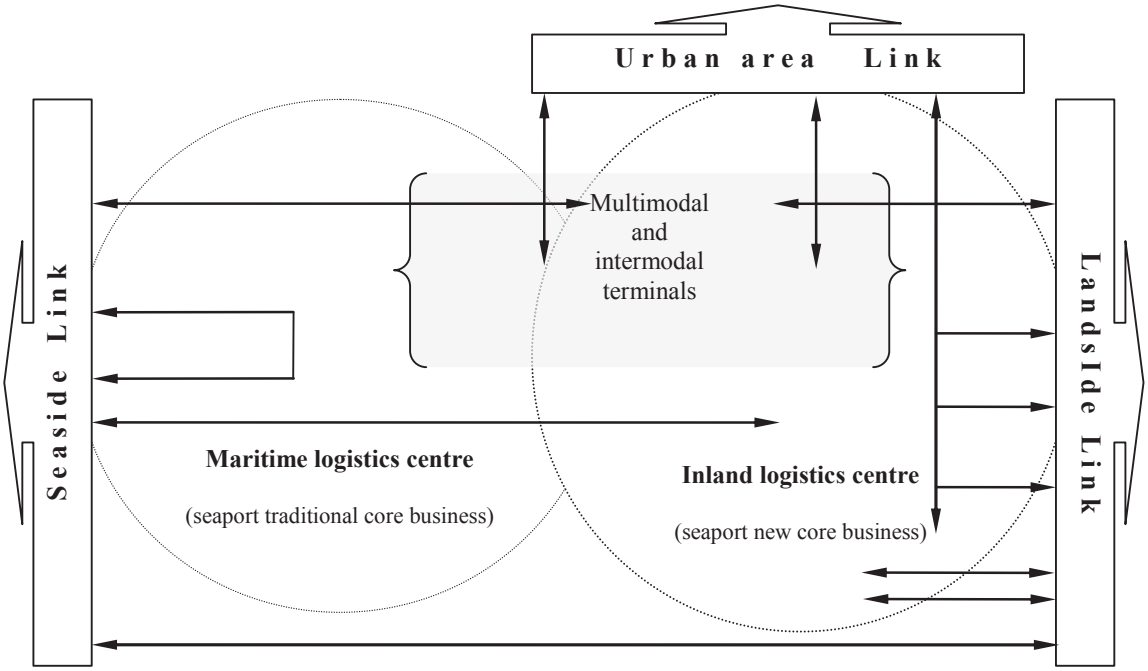

Fig. 3. Scope and potential of seaports beyond maritime and inland logistics centers(UNCTAD, 2004)

The logistics, forwarding and transport services for freight (goods) in the seaport functioning as maritime and inland logistics centers are much broader and can include (Fechner, 2009):

- receiving and storage of goods intended for production,
- consolidation of supply deliveries for production purposes,
- completion of assembly kits,
- delivery of goods to manufacturing companies, including sequential delivery to assembly lines,
- storage,
- consolidation and deconsolidation,
- picking and palletizing,
- finishing, including foiling, ticketing, minor repairs,
- cross-docking,
- inventory management by logistics operators / forwarders, and
- forwarding services, and
- transportation, including the transportation of cargo in the carriages of small parcels.

The above possible logistics, forwarding and transport services provided in the seaport do not differ from similar characteristics of integrated logistics centers. Therefore, the author used the source material by Fechner, who systematized blocks of services for freight provided only in logistics centers. If it is considered that the ports of the third and fourth generation are specific logistics centers or even logistics platforms, they normally shall have unified range of services provided both in typical integrated logistics centers, as well as seaports of the above generations (Montwiłł, 2013).

4. Seaports as logistics centers in the logistics supply and distribution in urban areas. Case study – Cityporto Padowa

On April 21, 2004, in Italy a service called "Cityporto Padowa" was launched, the aim of which was to provide regulations for the rationalization of freight transport and distribution in the city of Padua aiming to reduce air pollution in urban areas (http://www.cityporto.it, 30.03.2014). Service was created on the basis of an agreement between the Municipality, the Province and the Chamber of Commerce of Padova, the local Public Transport Company (APS Mobilità), and Interporto di Padova SPA (the company managing the logistics center). This project covered goods delivery to customers in the city center. "Cityporto Padowa" relies on a very simple scheme. Logistics operators, freight forwarders and other suppliers of goods to companies operating in the center of Padua deliver the goods to a distribution center located in the logistics center of Interporto Padowa. After being accepted to the warehouse, goods are sorted and next selected packages are loaded into environmentally friendly cars. The vehicles distribute the goods in the city, under the so called "last mile" service, which may be just the limited traffic zones or the entire city centre. Figure 4 shows a schematic functioning of the system.

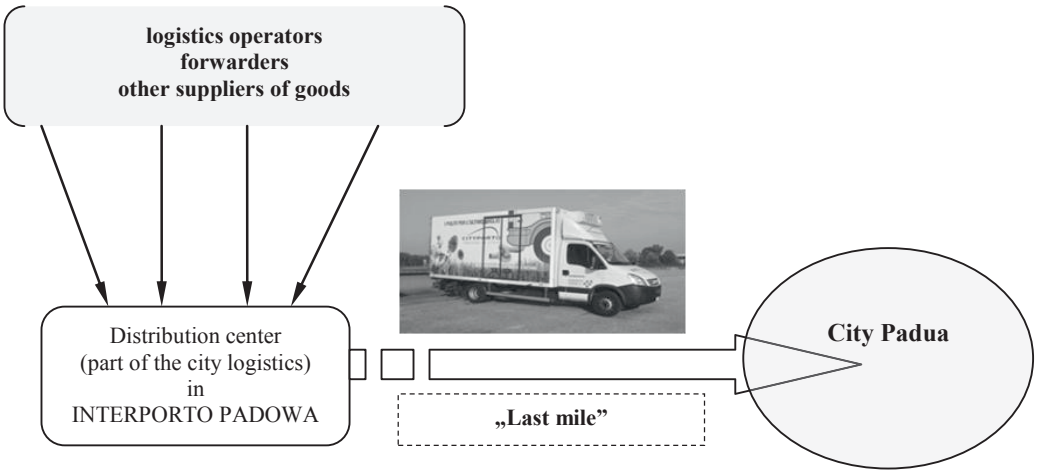

Figure 4. Scheme of the Cityporto Padowa system (http://www.interportopd.it, 30.03.2014)

"The 10 ecological vehicles used by Cityporto that provide the service with two "rounds" every day, one in the morning and one in the afternoon, **prevent more than 100 lorries and trucks entering the city every day**, some of them still Euro 1 and Euro 2 class, which is an enormous contribution to help relieve traffic congestion in the city." (http://www.cityporto.it, 30.03.2014). In 2012, these cars have done more than 100,000 deliveries optimizing transport routes through the use of the Tracking & Tracing IT systems for planning each delivery cycle.

Analysis of the system efficiency and optimization of delivery routes carried out in the period of 24 months (from July 2008 to June 2010) highlighted (http://www.cityporto.it, 30.03.2014):

- reduction of kms covered - 561400 km,
- daily average reduction – 1216 km,
- reduction of gas consumption (less freight transport vehicles circulating) – 58 200 litres,
- natural gas consumption of Cityporto CNG vehicles‡ - 3904 liters, and

‡ Compressed Natural Gas

- reductions of pollutants: Carbon Dioxide (CO2) – 216,65 ton, Nitrogen Oxide (NOx) – 369 kg, Sulfur Oxide (SOx) – 72,8 kg, Volatile Organic Compounds (VOC) – 210,4 kg and Particulate Matter (PM10) – 58,4 kg.

The delivery system applied in Padua achieved the set objective, which was to reduce congestion and pollution. The added value was the reduction in supply costs by optimizing the cost of "the last mile" services.

The above example of delivery system for packages/shipments represents one of the possible ways to use the structure of logistics centers located near urban areas in the process of improving the efficiency of urban logistics resulting in reducing congestion in urban areas, with particular attention to the city centers, the emission of pollutants by reducing the length of transport routes in supply of goods to stores and other customers, and the use of electric or gas vehicles in the "last mile" services. The use of a system similar to the one operating in Padua also results in reduction in the cost of distributing goods through economies of scale in service processes and storage of elements for many retailers, as well as optimization of supply in urban areas and increase in the efficiency of means of transport by centralizing management into one decision-making center.

Third and fourth generation of seaports with their developed objective and spatial functions take the form of inland logistics centers, and just like the classic logistics center they can perform tasks, the effect of which will be processes listed above. As indicated above, services implemented in the seaport include those related to freight, passengers, means of transport, cargo transport units, and in many cases, the production of goods. Figure 5 presents the range of services provided in ports.

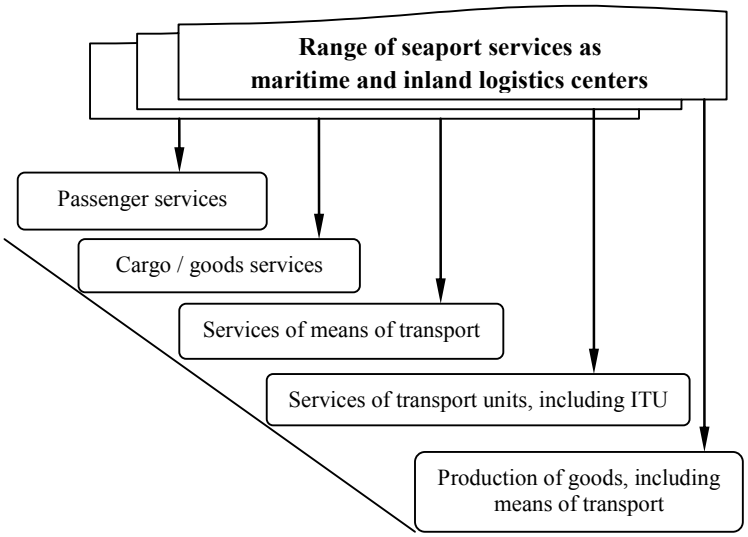

Figure 5. Range of seaport services as maritime and inland logistics centers

Operational and commercial sphere of the seaport logistics center gives the necessary technical and organizational capacity to provide a wide range of services not only in its area but also in the port city or metropolitan area (see Figure 3). From the point of view of economic and environmental aspects, seaport area is a perfect place for:

- distribution centers for numerous retailers, including the organization of delivery by seaports company, for example, such centers were created in many major European ports, such as: Rotterdam, Antwerp, Hamburg, Bremen,
- common parcel service companies with the organization of parcel delivery by seaports company,
- leasing, service and maintenance center for ecological vehicles (electric or CNG) used in the urban system of goods delivery to shops and shopping malls,

- cargo transport unit centers providing rental and delivery services, including small repairs and ITU§,
- service center for vehicles and handling of drivers delivering and receiving goods to/from inland logistics center of the seaport,
- centers for wholesale trade of different goods, including foodstuff; such centers were created in many major European ports, such as: Rotterdam, Antwerp, Marseille, Italy seaports,
- reception centers used for consumer goods, which aim to consolidate transport and the purpose of which is providing recycling service in the seaport's recycling and recovery center, which was already used in several European ports, and
- office centers for companies operating in both the port and the city, fulfilling the role of the trade center.

The solutions presented above aim to improve the city logistics system and show the essence of the seaport's urban function presented earlier in this article (Figure 1). The seaport becomes a part of the city implementing its functions in the particular area. The development of this function improves the urban transport and trade system for reducing congestion, pollution and distribution costs, and affects the development of the city and region.

5. Conclusion

Third and fourth generation of seaports operate as logistics centers with developed urban, logistics and distribution functions, and they increase the effectiveness of urban logistics and decrease the negative effects related to congestions and pollution. Currently, the reduction of the negative effects related to the functioning of the city and the region depends on the joint action of the port city and seaport. The potential for these types of seaports in reducing congestion and pollution in port cities is very large.

Activities of the third and fourth generation of seaports improve urban logistics efficiency by increasing the efficiency of supply chains, thus contributing to the objectives of the White Paper 2011 in the areas of port cities - Towards a competitive and resource efficient European transport system (White Paper, 2011).

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